

The Mode of Competition Between Foreign and Domestic Firms, Pass-Through, and External Adjustment

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Two literatures on external adjustment

- Quantities: Armington's (1969) notion of "origin-differentiation" is necessary to explain the volume of global trade and the rate of external adjustment following exchange rate movements. The degree of external adjustment depends on the degree of *substitutability between origins*.
- Prices: recent literature on pricing-to-market (PTM) focuses on price complementarities. The degree of PTM depends on the degree of *substitutability between varieties*.
- **How does "origin-differentiation" affect PTM decisions, spillovers into domestic prices, and how do the resulting movements in relative prices affect external adjustment?**

This paper: We augment AB's (Atkeson and Burstein 2008) heterogeneous firm version of Dornbusch (1987) with Armington's (1969) notion:

- We develop a three-tiered CES preference structure in which varieties are combined to produce a sector's output while foreign and domestic varieties are not equally substitutable within the sector.
- We structurally estimate the elasticity parameters in our preference framework using the information in the micro price data underlying the US import and producer price indices.
- We examine what our findings imply for relative price movements and external adjustment rates.

Preview of the results: we find a median elasticity between varieties of 9 and a median Armington elasticity of 4.

Untying the elasticity between varieties from the Armington elasticity has three key implications:

- There can be substantial pricing to-market by foreign firms even if these firms are small compared to the domestic industry.
- We find small, but still non-negligible price spillovers into domestic prices.
- **Our theory can reconcile how firms price to market with the aggregate rate of external adjustment.**

Related Literature

- Price complementarities: Melitz and Ottaviano (2008), AB, Gust et al. (2009, 2010), Gopinath and Itskhoki (2011), Berman et al. (2012), Auer and Schoenle (2012), Amiti et al. (2012), Hong and Li (2012), Devereux et al. (2013). These require high elasticities (10) to match prices.
=> We explain why PTM and large relative price movements are present even if goods from different origins are not very substitutable.
- Quantities: estimates of Armington elasticities (Feenstra (1994), Broda and Weinstein (2006), Feenstra et al. (2010), Imbs and Mejean (2012)) assume constant markups, use aggregate data, and are low (<5).
=> We examine adjustment when markups are variable and thus contribute to Berman et al. (2012), Gopinath and Neiman (2012), Gopinath et al. (2012), Alessandria et al. (2012), Droszd and Nosal (2011) and others.

This presentation:

- The model
- Empirics:
 - accounting for imported inputs,
 - mapping the theory to the data & GMM estimation,
 - (endogeneity of the exchange rate)
- Results & implications

Underlying Model: Dornbusch (1987)

- Nested demand system: Krugman (1987), Dornbusch (1987), AB, many others.
- Idea: 2-tiered CES demand, but do not make Dixit and Stiglitz (1977) assumption that a firm cannot influence sectoral price index.
- A tiny variety-producing firm $s_{n,k} \approx 0$ faces demand elasticity ρ , a monopolist $s_{n,k} = 1$ faces demand elasticity η
- With $s_{n,k} \in]0, 1[$ demand elasticity increases in own cost/exrate and decreases in the cost/exrate of **other** firms

Our Model

- In AB, sectoral output is

$$Y_k = \left(\sum_{n \in N_k^D \cup N_k^F} w_{n,k} (q_{n,k})^{(\rho_k-1)/\rho_k} \right)^{\rho_k/(\rho_k-1)}$$

- We add origin differentiation to this framework.

$$Y_k = \left(w_k \left(\sum_{n \in N_k^D} (q_{n,k}^D)^{(\rho_k-1)/\rho_k} \right)^{((\mu_k-1)\rho_k)/(\mu_k(\rho_k-1))} + (1-w_k) \left(\sum_{n \in N_k^F} (q_{n,k}^F)^{(\rho_k-1)/\rho_k} \right)^{((\mu_k-1)\rho_k)/(\mu_k(\rho_k-1))} \right)^{\mu_k/(\mu_k-1)}$$

- AB emphasize home bias w_k ; We emphasize $\mu_k < \rho_k$.

- $\mu_k = \rho_k$ corresponds to standard case. $\mu_k/\rho_k < 1$ measures the degree of origin-differentiation.
- Our framework relates to Feenstra et al. (2010), but is not to be confused with it.
- **Main novelty of our framework is that it unties firm pricing responses to own cost and the relevant index of competitors' prices from the degree to which the relevant index of competition reacts to prices from a different origin.**

Optimal Prices and Markups

$$P_{n,k}^F = \text{marginal cost} * \frac{\epsilon_{n,k}^F}{\epsilon_{n,k}^F - 1} \quad (1)$$

- with demand elasticity

$$\epsilon_{n,k}^F = - \left(1/\rho_k + \left((1/\mu_k - 1/\rho_k) + (1/\eta - 1/\mu_k) S_k^F \right) s_{n,k}^F \right)^{-1} \quad (2)$$

- compares to $\epsilon_{n,k}^F = - \left(1/\rho_k \left(1 - S_k^F s_{n,k}^F \right) + 1/\eta \left(S_k^F s_{n,k}^F \right) \right)^{-1}$
- Lower case s^F : market share within sector and origin
- Upper case S^F : market share of domestic firms

Price response to cost shocks

- We solve the above model following AB with a loglinearization around the steady state.
- Each firm's price depends on own costs, prices of firms from the same origin, and prices from a different origin.
- Firms are heterogeneous in their responses.
- If $\mu_k < \rho_k$, the markup of all domestic firms depends more on the prices of domestic firms than on foreign prices.

Price response to cost shocks II

$$\widehat{p}_{n,k}^F = \alpha_{n,k}^F \widehat{c}_{n,k}^F + \delta_{n,k}^F \widehat{P}_k^D + \zeta_{n,k}^F \widehat{P}_k^F$$

- $\alpha_{n,k}^F$: the rate (elasticity) at which foreign firm n reacts to changes in its own cost
- $\delta_{n,k}^F$: the rate at which foreign firm n reacts to the price level of the domestic composite
- $\zeta_{n,k}^F$: the rate at which foreign firm n reacts to the price level of the foreign composite. If $\mu_k < \rho_k$ $\zeta_{n,k}^F < \delta_{n,k}^F$.
- For given parameters $\alpha_{n,k}^F$, $\delta_{n,k}^F$, $\zeta_{n,k}^F$ are functions of S_k^F and $s_{n,k}^F$ only.

Industry equilibrium price response to cost shocks

Our theory maps the market structure of heterogeneous importers and heterogeneous domestic firms into a equilibrium pricing response to local and foreign cost shocks (as in Auer and Schoenle (2012)).

Main implications:

- For small μ_k , ERPT is incomplete even if importers are small compared to domestic industry.
- Small μ_k leads to limited PT also into PPI.
Important empirically: PT into PPI equal to around 1/3 of PT into IPP
- Small μ_k thus implies large RELATIVE price movements.

Industry equilibrium price response to cost shocks

The price response of the domestic price index is equal to

$$\widehat{P}_k^D = \frac{1}{\left(1 - \Delta^D\right) - \frac{Z^D}{1-Z^F} \Delta^F} \widehat{C s}_k^D + \frac{\frac{Z^D}{1-Z^F}}{\left(1 - \Delta^D\right) - \frac{Z^D}{1-Z^F} \Delta^F} \widehat{C}_k^F$$

where, for example

$$\Delta^D = S^D \sum_{n,k \in N_k^D} s_{n,k}^D \widehat{\delta}_{n,k}^D$$

Estimation

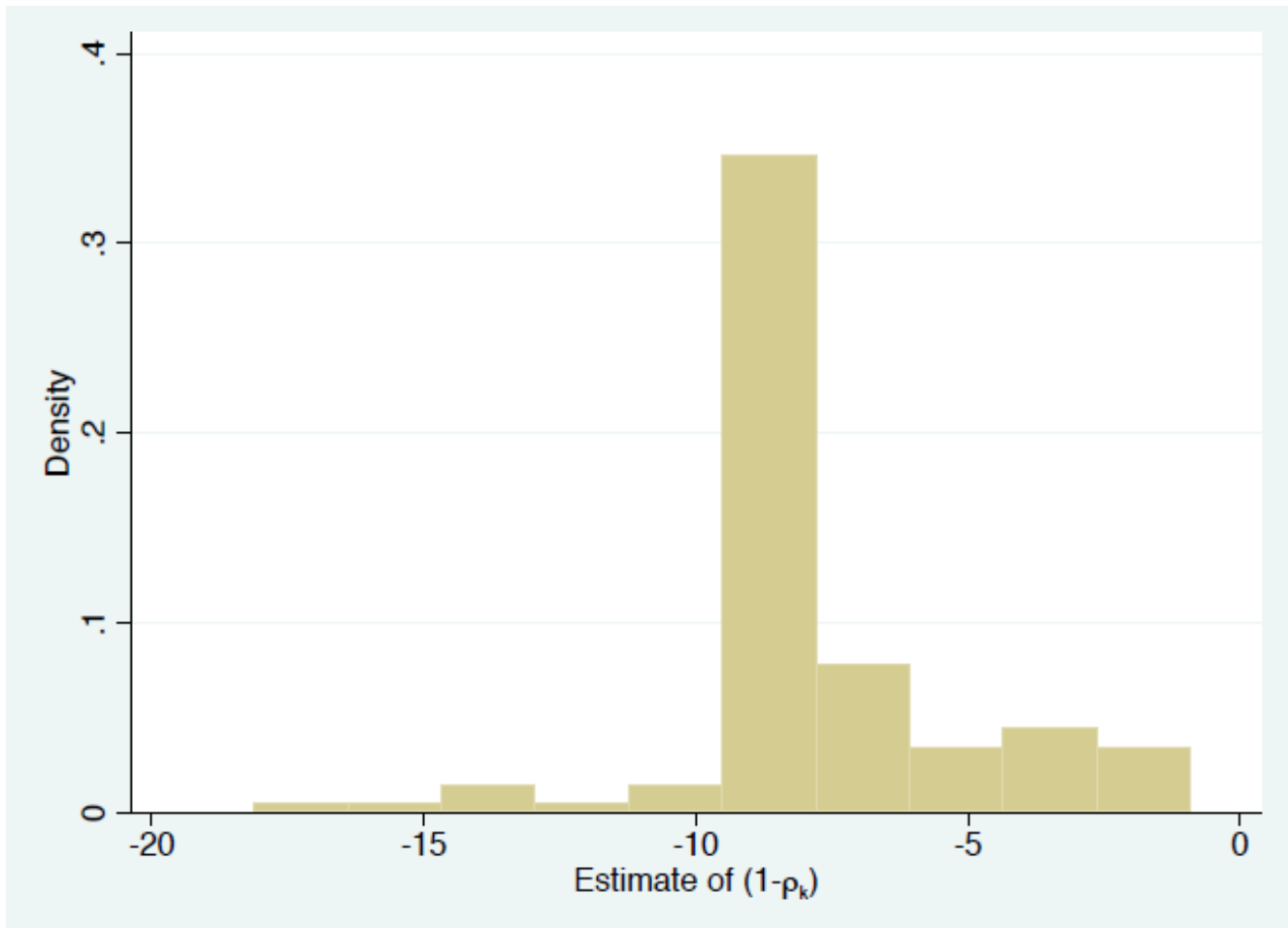
- We use the micro dataset underlying IPP and PPI from the BLS to estimate the parameters of this model.
- We construct market shares as in Auer and Schoenle (2012) and Gilchrist et al. (2012).
- We take into account the importance of imported inputs (see next slide)
 - foreign firms use inputs, which affects their PTM
 - domestic firms import inputs

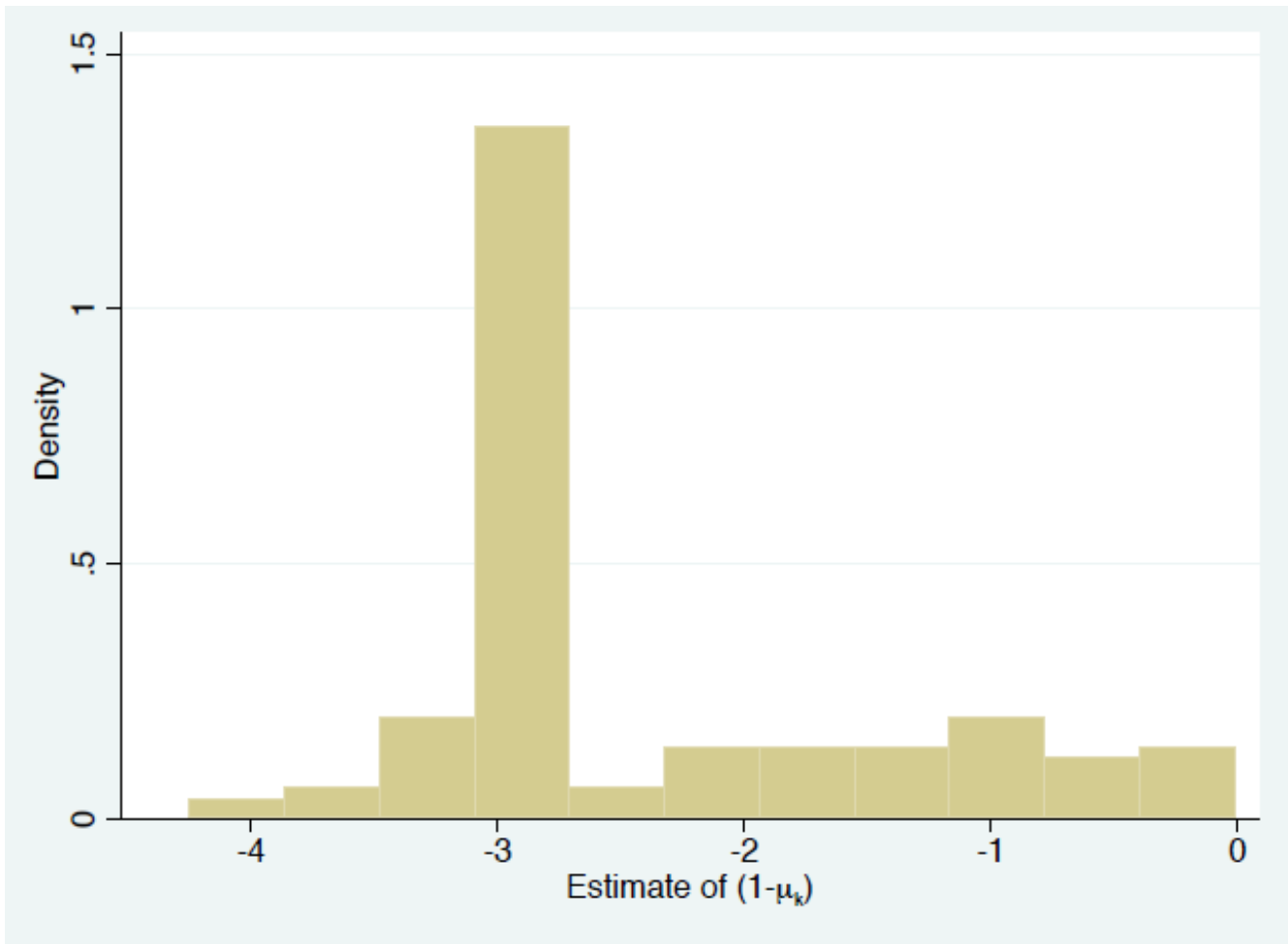
Accounting for Imported Inputs

- To account for imported inputs used by US firms, we
 - Build a sector-trade partner specific price index following Schott (2004)
 - Estimate cost impulse to exchange rate using this price index and the sector-trade partner specific input cost share in each US industry using the input-output table (from WIOD).
 - We also account for the heterogeneity in input use pointed out by Amiti et al. (2012) by allocating inputs to heterogeneous firms.
- To account for imported inputs in *other* nations, we again use WIOD: for each trade partner TP and each supplying sector, we calculate the fraction of inputs that the FOREIGN industry uses.

Estimation II

- We assume that exchange rate changes (adjusted for input costs) are cost drivers.
- We estimate the model using GMM:
 - Assume that firms compete within NAICS 6d.
 - Identify parameters from the response of domestic and import prices to the TW exchange rate.
 - To avoid aggregation bias (Imbs et. al (2005)), we estimate sector-specific parameters.





Implications for PRICES

- μ_k around 4 while ρ_k around 9 rationalizes:
 - Pricing to market by importers is substantial also when they in sum only account for a small fraction of a US sector. Important empirically: in the US, $S^F \approx 15\%$ while $ERPT \approx 0.3$. With $S^F \approx 15\%$ you cannot get ERPT that low even if $s_{n,k}^F = 1$. Potentially important for Berman et al. (2012) and Amiti et al. (2012).
 - Pro-competitive price spillovers into domestic PPI: limited, but not negligible (see also Goldberg and Hellerstein (forthcoming), Goldberg et al. (2013)).
 - Thus, sectoral RELATIVE price movements are large (see Burstein and Jaimovic (2012).)

Implications for the EAR

- EAR is the degree of origin-differentiation times the relative price movement. Change of the market share of importers is equal to:

$$\begin{aligned}\widehat{S}_k^F &= (1 - \mu_k) \left(\widehat{P}_k^F - \widehat{P}_k \right) \\ &= (1 - \mu_k) (1 - S_k^F) \left(\widehat{P}_k^F - \widehat{P}_k^D \right)\end{aligned}$$

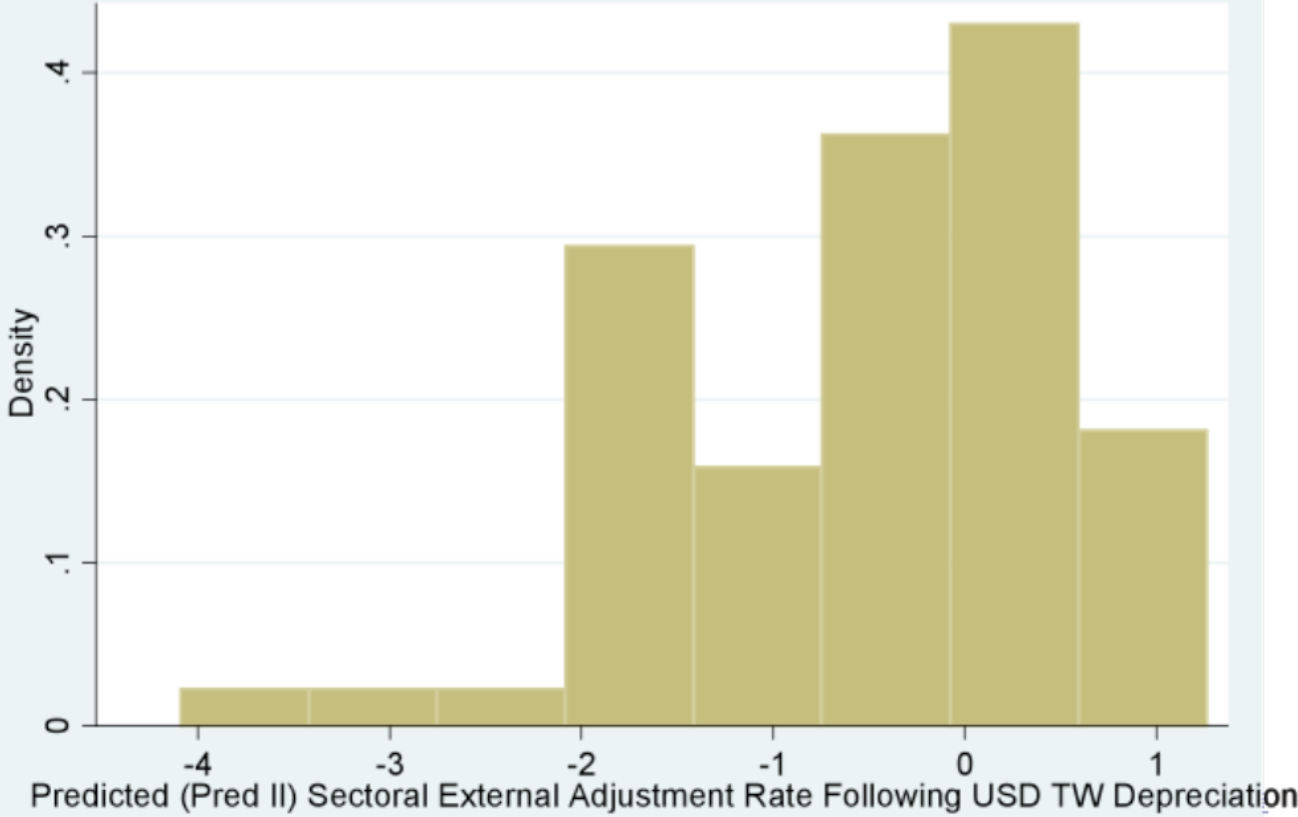
- μ_k is small (big difference since $1 - \mu_k = -3$ while $1 - \rho_k = -8!$)

ERA and its Decomposition (all numbers are medians)

$$\underbrace{\widehat{S}_k^F}_{-0.708} = \underbrace{(1 - \mu_k)}_{(I): -3.01} \underbrace{(1 - S_k^F)}_{(II): 0.89} \underbrace{\frac{(1 - \Delta^D) - Z^D}{(1 - Z^F)(1 - \Delta^D) - Z^D \Delta^F}}_{(III): 0.307} \widetilde{C}_k^F$$

- (I): Origin differentiation
- (II): Importance of foreign prices on overall price index
- (III): Equilibrium relative price movement

Predicted Sectoral Adjustment Rates



of Competition Between Foreign and Domestic Goods, Pass Through, and External Adjustment

Identification (TBD)

- We have used exchange rate fluctuations as a source of cost fluctuations.
- How endogenous is the exchange rate?
 - We have accounted for input-output linkages and we can also control for unit labor cost changes and exit and entry.
 - However, we need to control for unobserved demand & supply shocks.
- **Idea: use the structure of our model (heterogeneous response to cost shocks, other prices, and demand shocks) for identification.**

Identification (simplified)

- With demand shocks, the augmented price response is

$$\widehat{p}_{n,k}^F = \alpha_{n,k}^F \widehat{c}_{n,k}^F + \zeta_{n,k}^F \widehat{P}_k^F + \gamma_{n,k}^F \widehat{d}_k$$

where $\widehat{d}_k = \frac{1-w_k}{w_k}$.

- Key: response to $\widehat{c}_{n,k}^F$ and \widehat{d}_k heterogeneous across firms, so a multifirm estimation can distinguish them. For example, equilibrium average price change

$$\widehat{P}_k^F = A_{n,k}^F \widehat{c}_{n,k}^F + F_{n,k}^F \widehat{d}_k$$

- we can solve this as

$$\widehat{p}_{n,k}^F = e_1 \widehat{c}_{n,k}^F + e_2 \widehat{P}_k^F \text{ for all } n \text{ s.t. } \widehat{P}_k^F = \sum s_{n,k} \widehat{p}_{n,k}^F$$

where

$$e_1 = \left(\alpha_{n,k}^F - \left(\gamma_{n,k}^F \left(F_{n,k}^F \right)^{-1} \right) A_{n,k}^F \right)$$

and $e_2 = \left(\gamma_{n,k}^F + \zeta_{n,k}^F F_{n,k}^F \right) \left(F_{n,k}^F \right)^{-1}$

- This constrained estimation is akin to including country-sector-time effects (such as Amiti et al. (2012)), which we cant do due to heterogeneity in responses. But we can use the heterogeneity in responses to shocks to identify the system of prices.

Conclusion

- We incorporate the Armington assumption into the theory of pricing to market of Dornbusch (1987), and Atkeson and Burstein (2008).
- Our theory improves our understanding of ERPT, spillovers into domestic prices, and thus relative price movements.
- Relative price movements and the rate of external adjustment are jointly determined. We thus contribute to literature explaining how variable markups affect external adjustment.
- Our paper is the first to structurally estimate the Armington elasticity from prices. The findings are interesting from a domestic context and have implications regarding the estimation of the gains from trade.

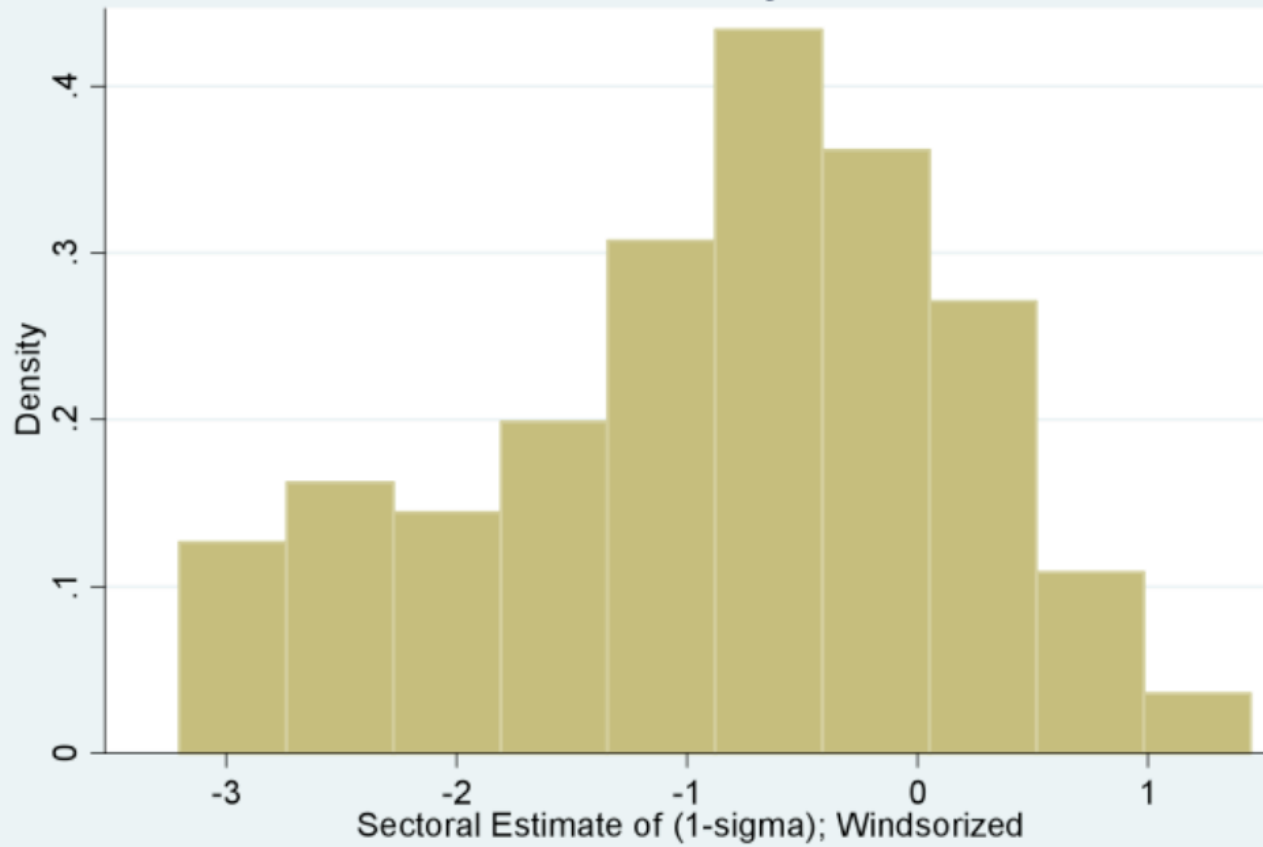
We estimate the following specification:

$$\Delta M_{k,t} = \alpha_k + \sum_{j=1}^n \beta_{k,j} \Delta e_{k,t-j+1}^{TW} + \sum_{j=1}^n \gamma_{k,j}^{TP} \Delta \pi_{k,t-j+1}^{TP} + \epsilon_{k,t},$$

where we use the monthly Trade-Weighted (TW) US exchange rate and overall sector-specific imports.

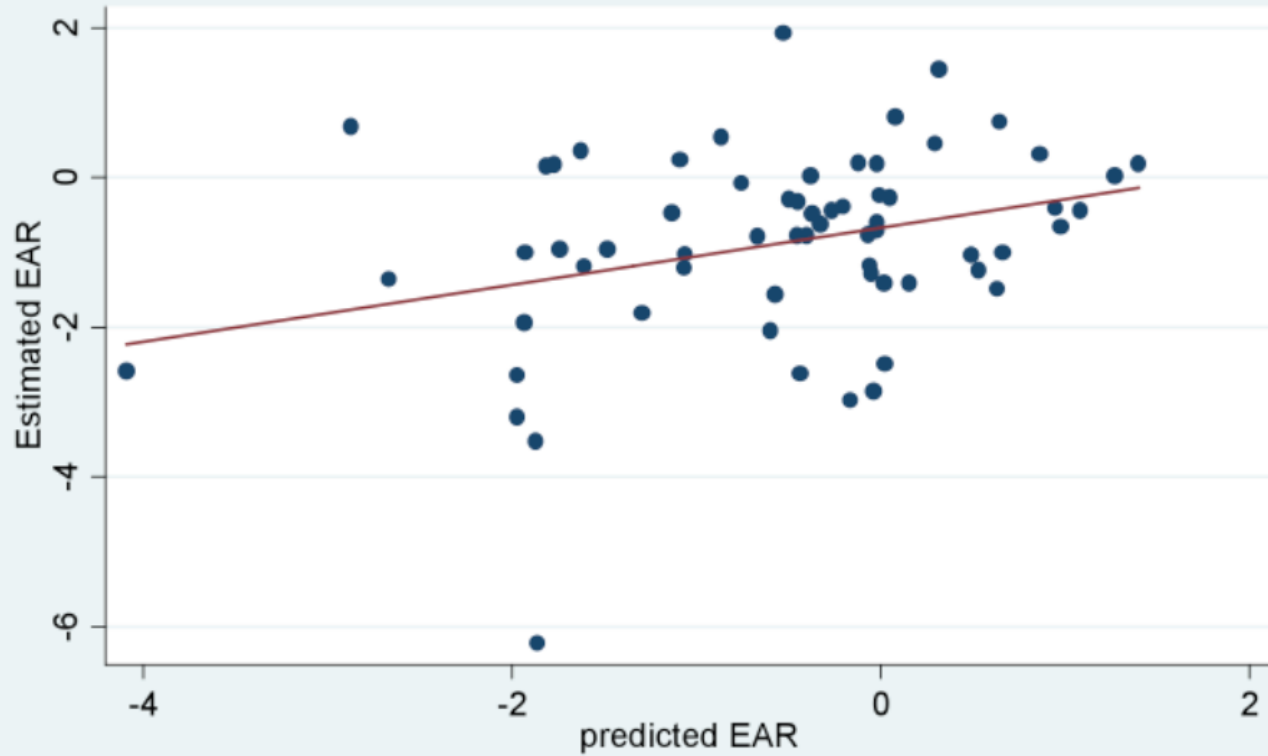
- We thus focus exclusively on the macro elasticity of Feenstra et al. (2010).

Estimated Sectoral Adjustment Rates



- **We also explain the heterogeneity of EARs in the data with our theory:**

Estimated and Predicted 24m EAR



● (mean) EAR_N6_coeff — Fitted values